OFFICE OF BUILDING TECHNOLOGY
STATE AND COMMUNITY PROGRAMS

2000 International Energy Conservation Code

U.S. Department of Energy
Office of Codes and Standards

Using

COM*check*-EZ™

Produced by Pacific Northwest National Laboratory

Scope and Application

ENVELOPE COMPLIANCE

MECHANICAL COMPLIANCE

LIGHTING COMPLIANCE

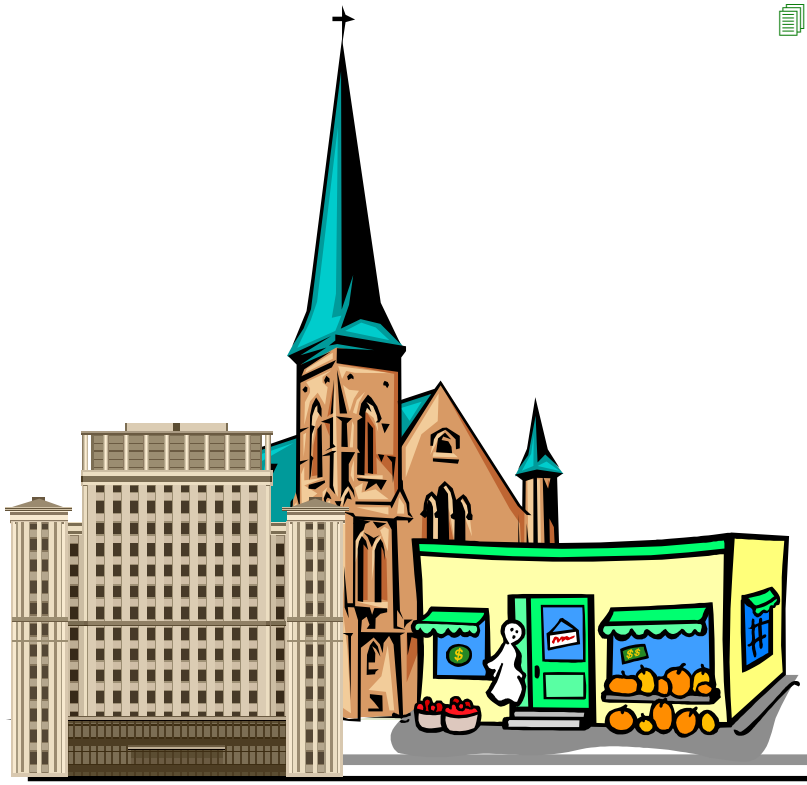
SOFTWARE

What is COM*check-EZ* ™?

- Method for demonstrating compliance with Chapter 8 of the 2000 IECC
- Resultant building will generally meet or exceed the energy efficiency of a building constructed to ASHRAE/IES Standard 90.1-1989
- COM*check-EZ* can be used when adopting authority has approved its use

What Buildings Does COM*check-EZ* ™ Apply To?

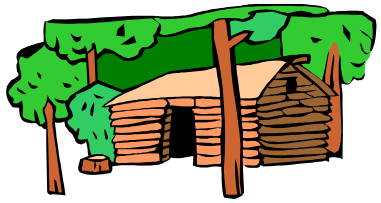
- Building type list changes depending on what code is selected for compliance



- Examples include
  - Offices
  - Retail, Grocery and Wholesale Stores
  - Restaurants
  - Assembly and Conference Areas
  - Industrial Work Buildings
  - Commercial or Industrial Warehouses
  - Schools and Churches
  - Theaters
  - Apartment Buildings with Four or More Habitable Stories
  - Hotels and Motels

Exceptions

- Very low energy use buildings
  (<3.4 Btu/h-ft^2 or 1 W/ft^2)



- Buildings (or portions of) that are neither heated nor cooled
- Buildings designated as historic

Overview of the COM*check-EZ* ™ Materials

- Scope and Application Compliance Guide
- Envelope Compliance Guide
- Mechanical Compliance Guide
- Lighting Compliance Guide
- Software Compliance Guide

COM*check-EZ* ™ Compliance Process

Each element must comply on its own

- Envelope
- Lighting
- Mechanical

Newly Conditioned Space

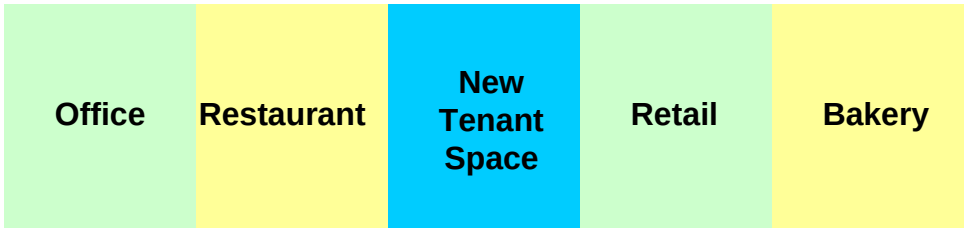
(Previously Unconditioned)

- Envelope, mechanical and lighting systems must be brought into compliance
- Potential problem areas
  - Building envelope
  - Lighting system
- Recommendations
  - Demonstrate compliance for systems at the time of permit

New Construction in Existing Buildings

(Tenant Improvements)

- New system(s) must comply
  - Envelope (should already comply)
  - Mechanical
  - Lighting



Alterations to Existing Spaces

- Applies to only portions of the systems being altered
- Applies if alteration increases energy use
- Alterations must meet the requirements applying to the altered component
- New systems in the alterations must comply

Additions

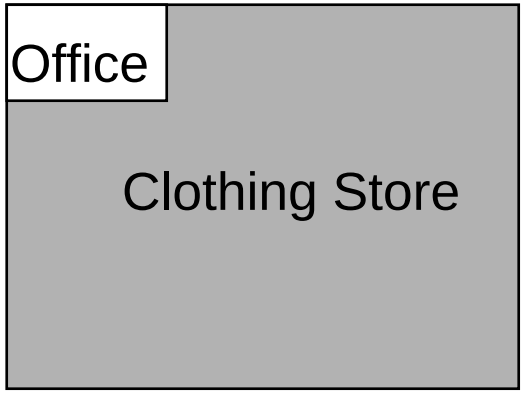
- Construction of new conditioned space or the conditioning of previously unconditioned space
- Treat the envelope, lighting, and mechanical systems as if the addition were a new building

Additions (cont'd)

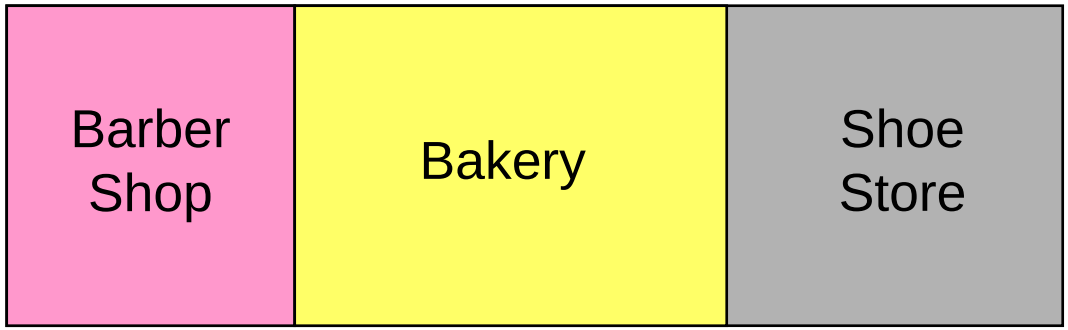
- Compliance options for additions
  - Treat as a stand-alone building
  - Bring entire building into compliance

Mixed Use Buildings

- Minor occupancy
  - <10% of floor area
  - Treat as major occupancy



- Different commercial occupancies
  - Treat building under the same compliance process as single occupancy building

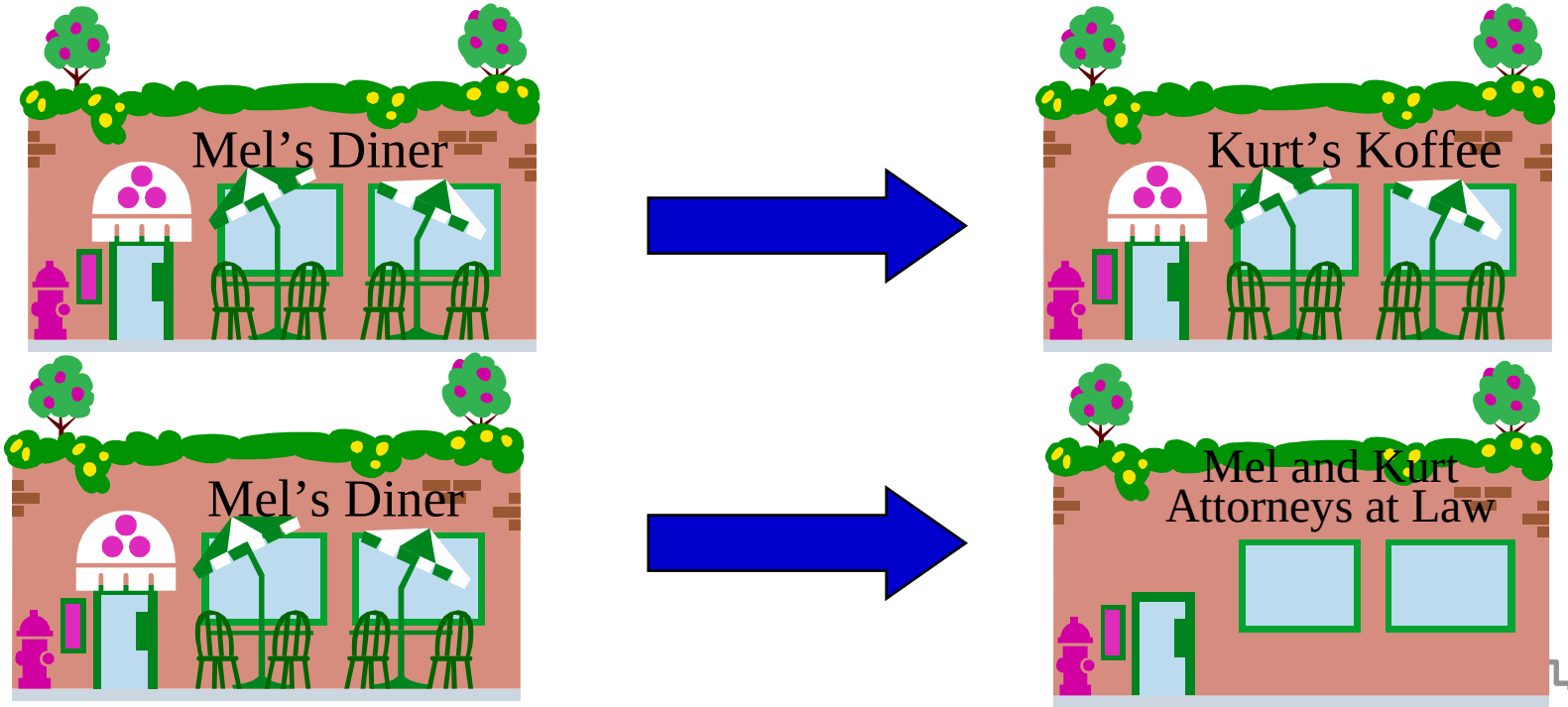


Mixed Use Buildings *(cont'd)*

- Hotel/motel and commercial occupancies
  - Treat as different commercial occupancies
- Mixed residential and commercial occupancies
  - Treat the residential occupancy under the applicable residential code
  - Treat the commercial occupancy under the commercial code

Change in Occupancy

- No action is required if alterations are not made to the building systems



SCOPE AND APPLICATION

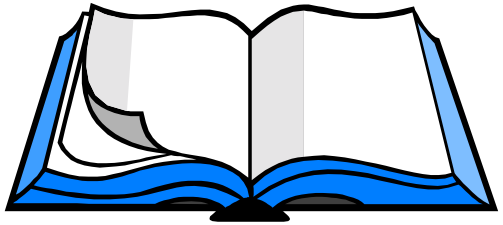
Envelope Compliance

MECHANICAL COMPLIANCE

LIGHTING COMPLIANCE

SOFTWARE

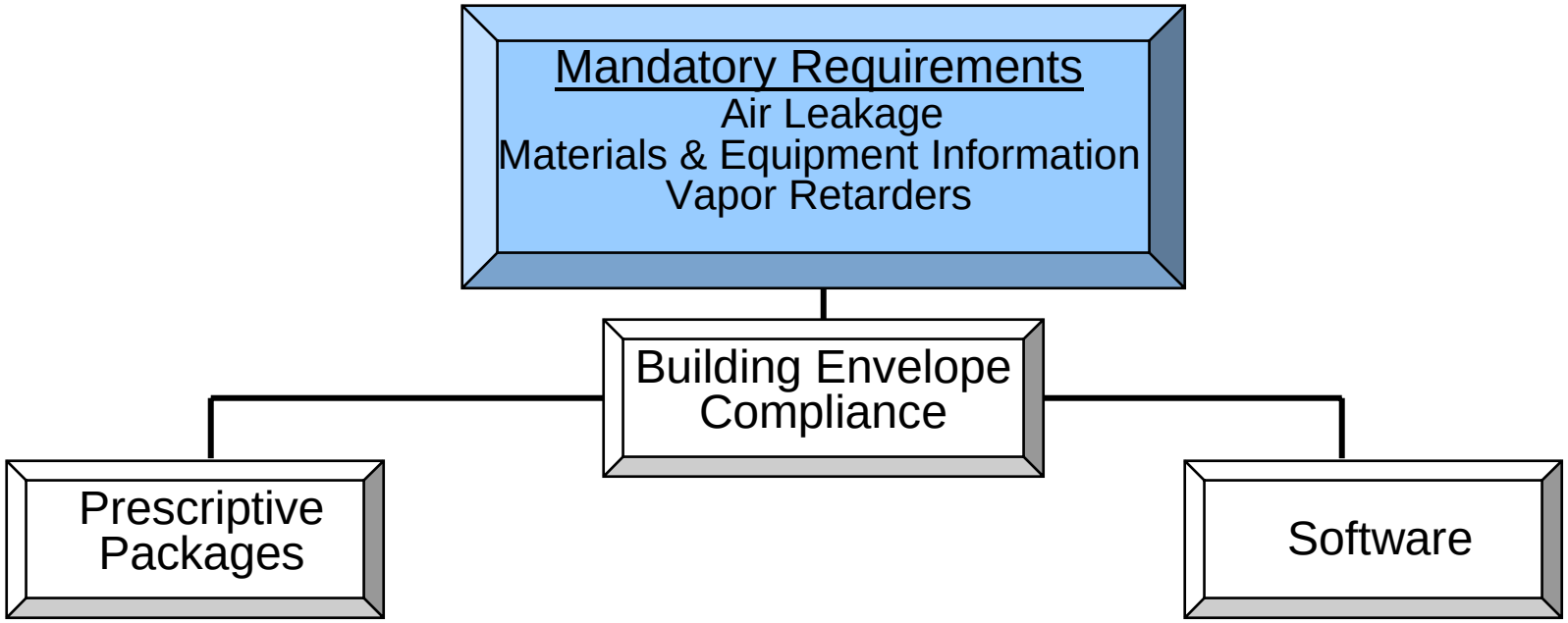
Scope



- Applies to the building envelope surrounding conditioned space
- Affects heating and cooling system

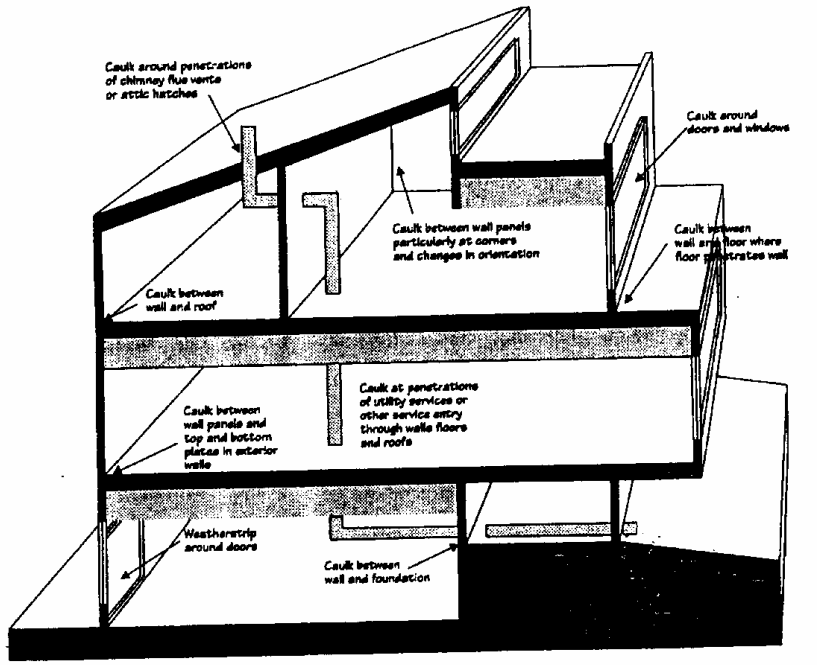
Scope

- Envelope requirements



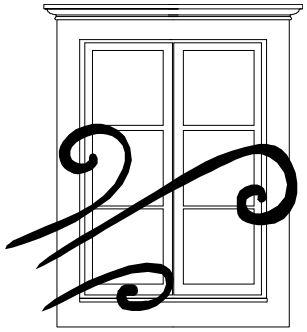
Air Leakage

- Caulk, gasket, weatherstrip or otherwise seal all joints and penetrations in the building envelope



Infiltration Controls

Air Leakage



- Manufactured window and door air leakage rates
  - Labeled windows and doors enforced at point of manufacturer
  - Non-labeled windows and doors ~ use manufacturers test results

Frame Type	Windows (cfm per ft. of operable sash cracks)	Doors (cfm per sq. ft. of door area)	
		Sliding	Swinging
Wood	0.25	N/A	0.25
Aluminum	0.37	0.37	1.25
PVC	0.06	0.37	N/A

Maximum Allowed Air Leakage Rates

Materials and Equipment Information

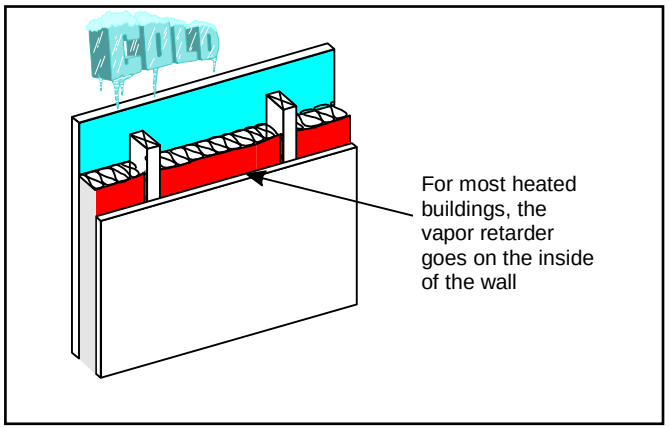
- Identify materials and equipment used for compliance
  - Building Plans
    - U-values of windows and doors
    - SHGC of windows
    - R-values of all insulation
    - Window dimensions on floor plans or window schedule

Materials and Equipment Information

- Building Site
  - Labels on insulation and windows
  - Contractor certification statements
  - Blown-in insulation
    - Initial installed and settled thickness
    - Coverage area and number of bags
    - “Guaranteed R-value” products

Vapor Retarder

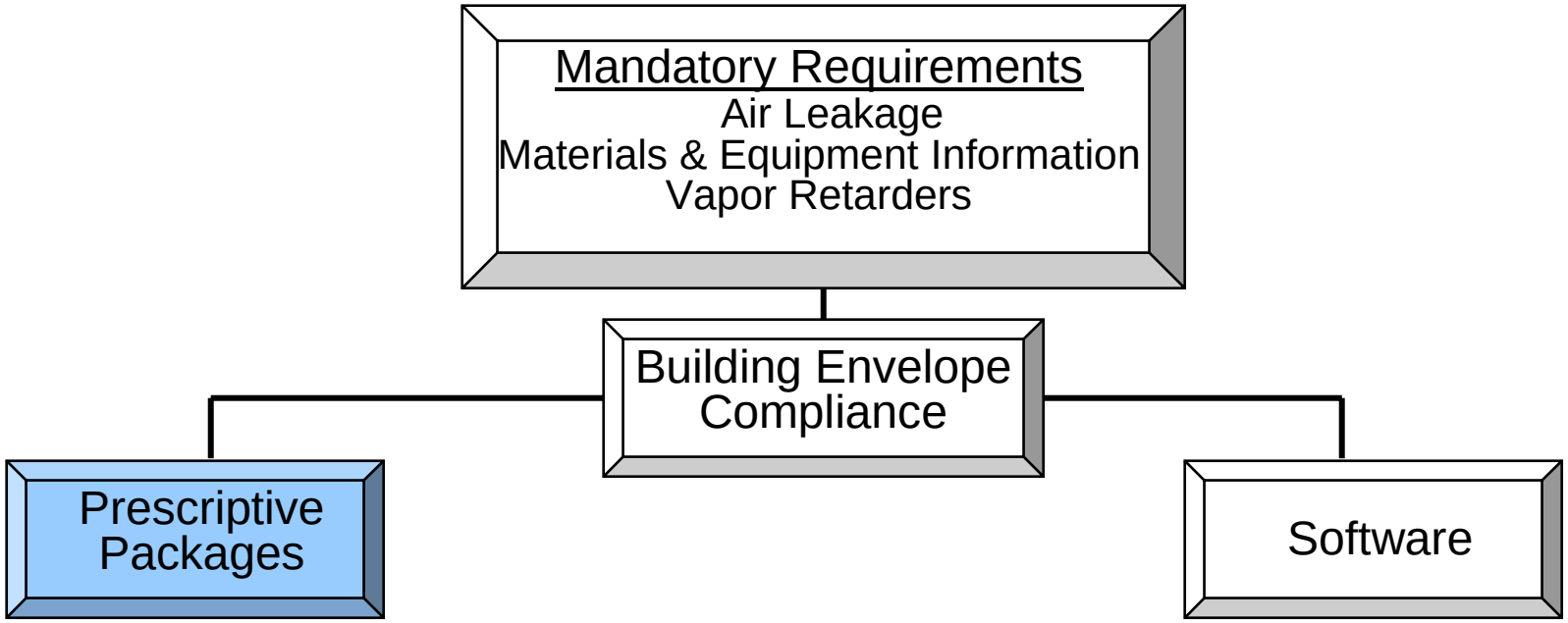
- Install in nonvented framed ceilings, walls, floors
- Must have a Perm Rating of ≤ 1.0
- Install on the “warm-in-winter” side of insulation



Vapor Retarders

- Exceptions
  - All of climate zones 1-7 are exempt from this requirement (check your state maps)

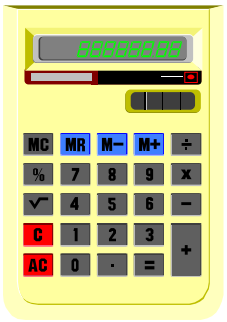
Building Envelope Compliance



Prescriptive Packages

- For buildings with 50% WWR or less
- Minimal calculations
- Based on:
  - Climate zone
  - Window wall ratio
  - Construction assembly
- All components must meet or exceed package requirements

Show Example Packages

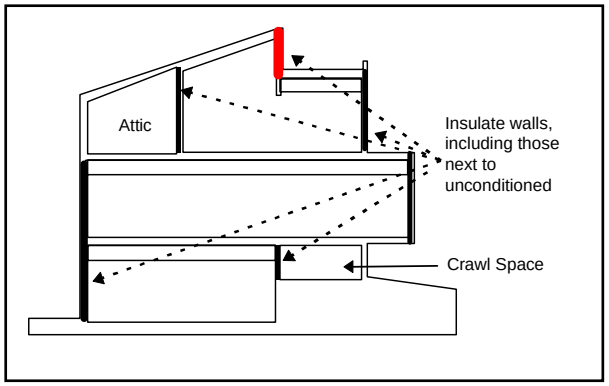


Prescriptive Packages

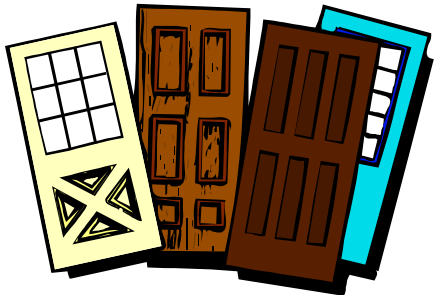
- Window-wall ratio (WWR)
  - Gross window area / gross wall area
  - Gross wall area includes
    - Above-grade walls
    - Band joist and subfloor between floors
    - Area of all doors and windows

Prescriptive Packages

- Walls
  - Walls next to unconditioned space
    - "Low fenestration area"

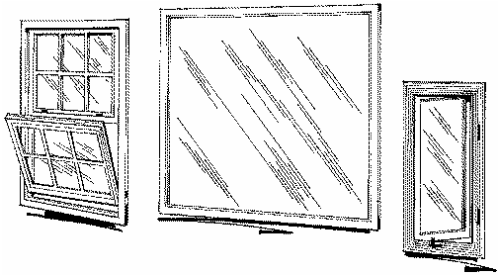


- Doors
  - <5% of gross wall area ~ No requirement
  - Sliding glass and atrium doors that function as windows
    - Must meet window requirements
  - >5% of gross wall area
    - R-value requirements for the predominant wall construction class

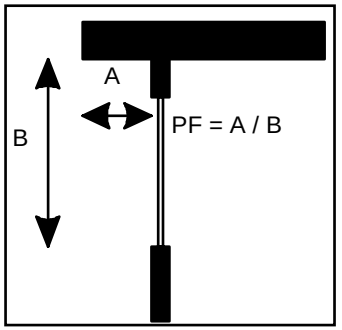


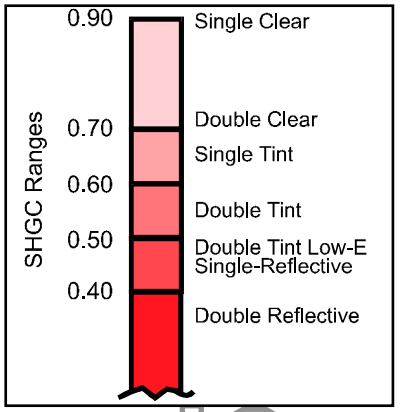
Prescriptive Packages

Windows



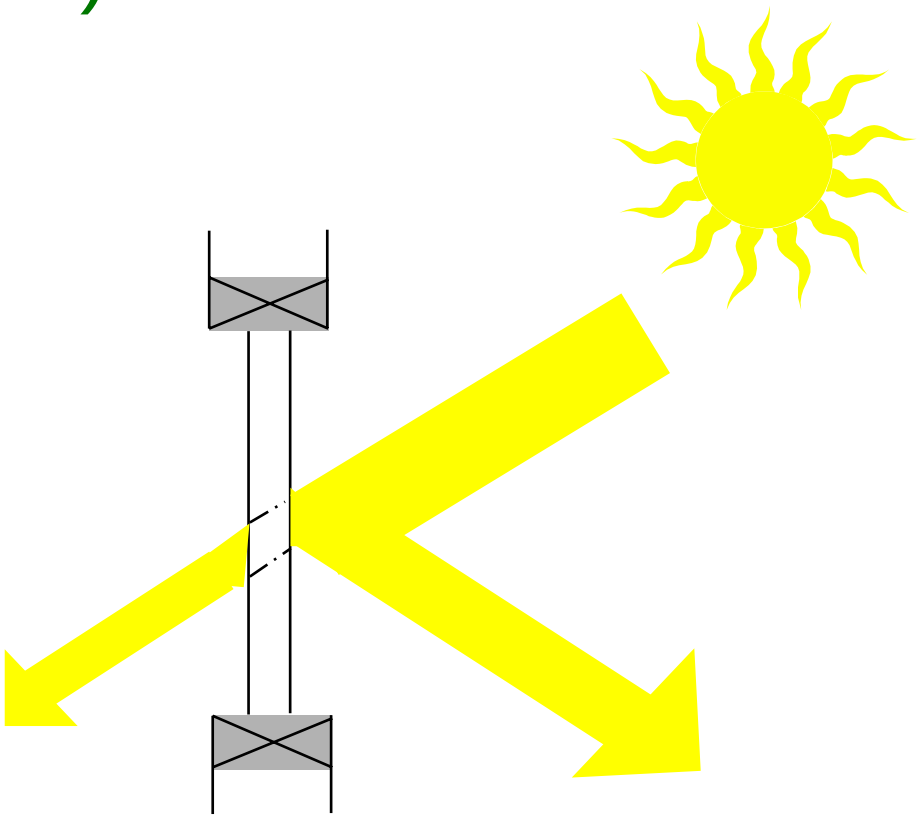
- Requirements based on
  - Solar Heat Gain Coefficient
    - Requirements dependent on projection factor
    - National Fenestration Rating Council (NFRC) tested
    - Default SHGC range diagrams
  - Maximum U-value

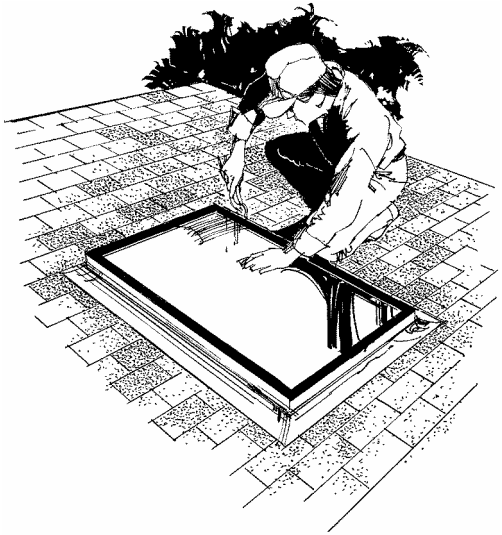




Solar Heat Gain Coefficient (SHGC)

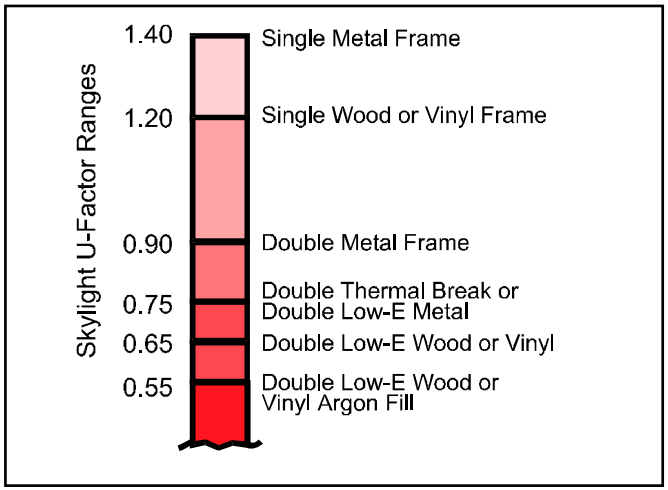
- The glazing's effectiveness in rejecting solar heat gain
- Part of a system for rating window performance
  - used by the National Fenestration Rating Council (NFRC)
- Gradually replacing shading coefficient (SC) in product literature and design standards
  - convert SC to SHGC by multiplying the SC value by 0.87





Prescriptive Packages
Skylights

- Restricted to ≤ 3% of roof area
- Requirements based on
  - U-value ~ NFRC tested or default U-value table

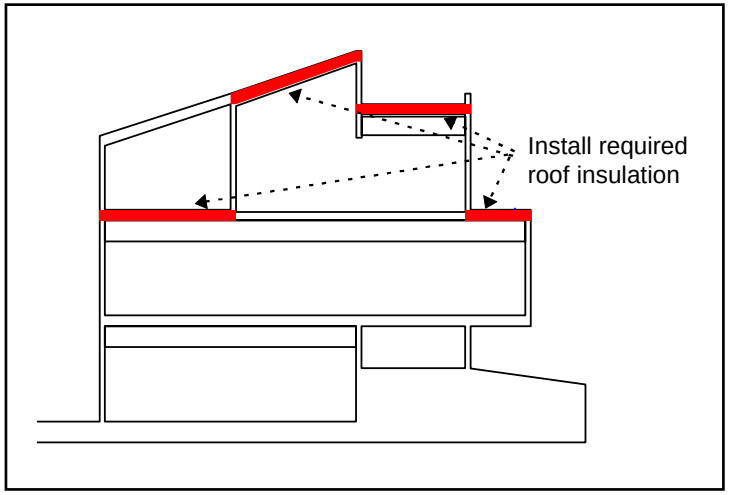


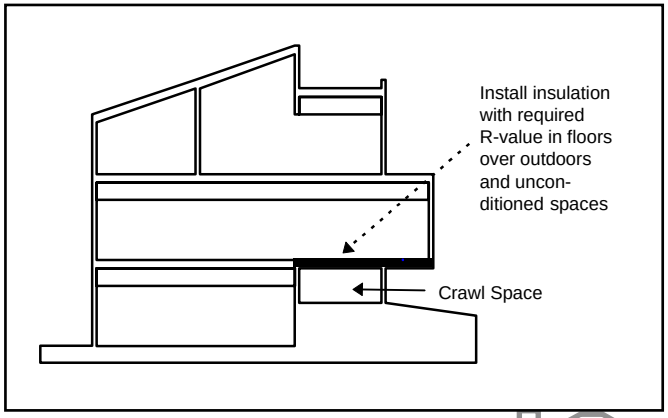
Default Skylight U-Value Ranges

Prescriptive Packages

Roofs and Floors

- Requirements based on
  - Assembly type
  - Continuous insulation
  - Cavity insulation
- All R-values must meet or exceed



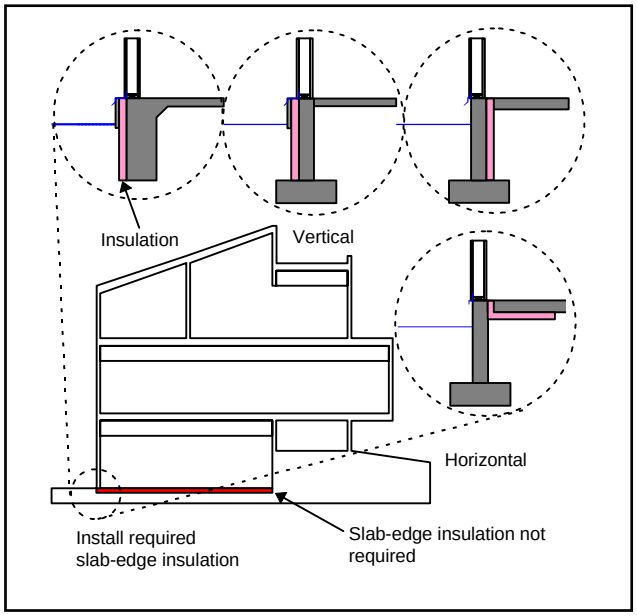


Roof Systems Insulation

Prescriptive Packages

Floors

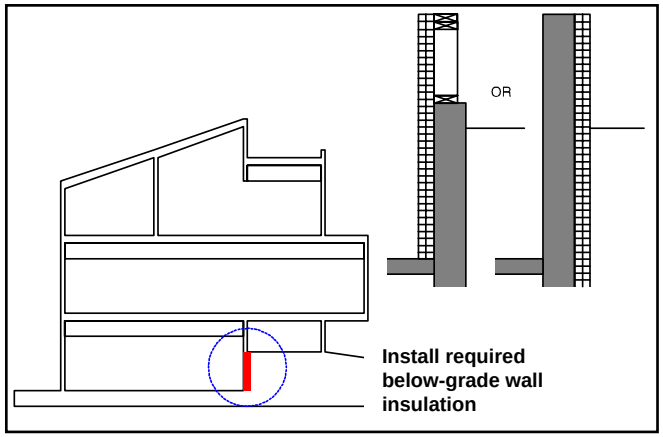
- Slab edge insulation
  - Proposed R-value must meet or exceed



Prescriptive Packages

Basement Walls

- Surface area in direct contact with the Earth
- Proposed R-value(s) must meet or exceed required R-value
- Cavity insulation
- Insulating sheathing



SCOPE AND APPLICATION

ENVELOPE COMPLIANCE

Mechanical Compliance

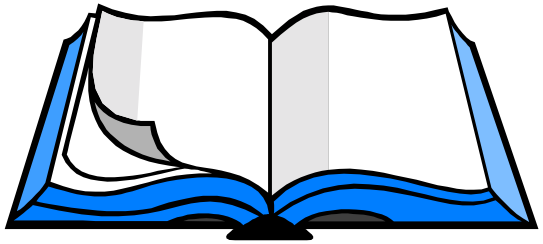
LIGHTING COMPLIANCE

SOFTWARE

Scope

- COM*check-EZ* ™ encourages efficient mechanical design by:
  - Requiring minimum equipment efficiency
  - Minimizing distribution losses in ductwork
  - Optimizing system controls
  - Requiring acceptable levels of outdoor ventilation
  - Requiring hydronic heating system features to reduce distribution losses
  - Requiring specific water-heating system components to reduce distribution and standby losses

Scope



- Systems that provide heating, cooling or ventilation for human comfort
- Exception: Systems that serve an industrial process

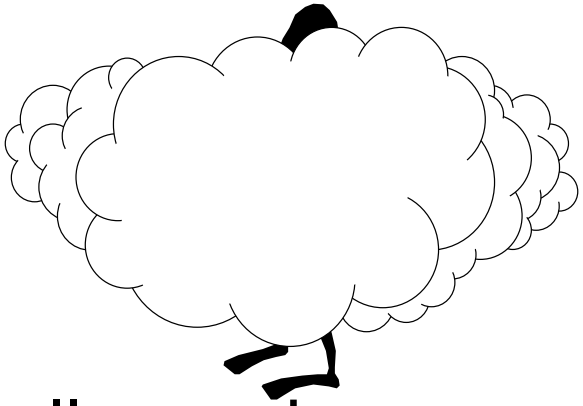
Equipment Efficiency

- Most packaged equipment is covered by NAECA and therefore already meets the requirements before it can be sold

NAECA

- National Appliance Energy Conservation Act
- Specifies equipment performance of heating and cooling equipment, water heaters, and other equipment
- Applicable equipment must meet NAECA before it can be sold in the United States - *No need to enforce at the building department counter*

Outdoor Ventilation Air and Exhaust



- Applies to all enclosed spaces normally used by humans
- Spaces must be continuously ventilated
  - Mechanically
  - Naturally
- Use either:
  - Building or mechanical code of local jurisdiction
  - Chapter 4 of the ICC International Mechanical Code (IMC)

Mechanical Ventilation

- Requirements for mechanically ventilated spaces
  - Minimum ventilation rates
  - System controls
  - Dampers

Mechanical Ventilation

Minimum Ventilation Rates

- Chapter 4 of the IMC

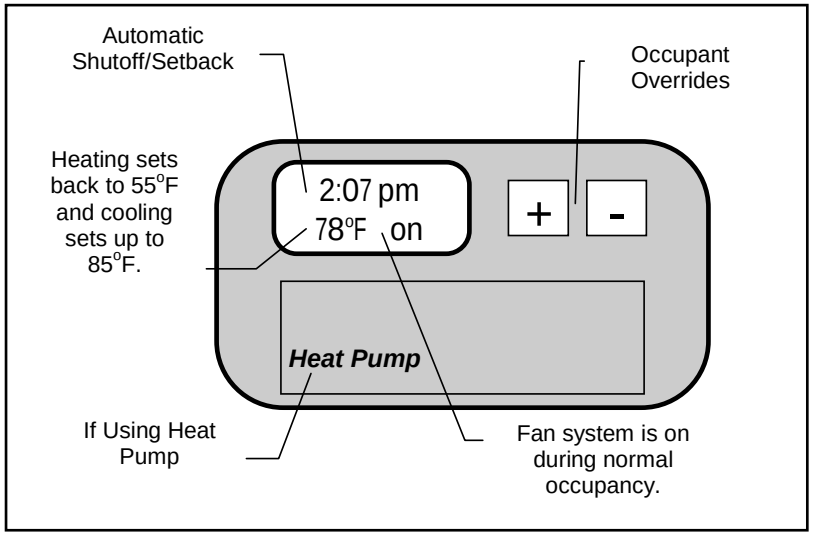
Building Type	Ventilation Rate (cfm per s q ft)
Auto Repair Workshop	1.5
Auditorium	2.25
Barber Shop	0.38
Bar, Cocktail Lounge, Casino	3.0
Beauty Shop	0.63
Cafeteria/Fast Food	2.0
Dry Cleaning	0.9
High-Rise Residential	Per IMC Section 403.3
Hotel Guest Room	30 cfm/room
Office	0.14
Retail Store (basement and street)	0.30
Retail Store (upper floors)/Mall	0.20
All Other s	Per IMC Section 403.3

Required Outdoor -Air Ventilation Rates

Mechanical Ventilation

System Control Requirements

- Must have the capability of controlling for continuous ventilation



Mechanical Ventilation

Shutoff Dampers

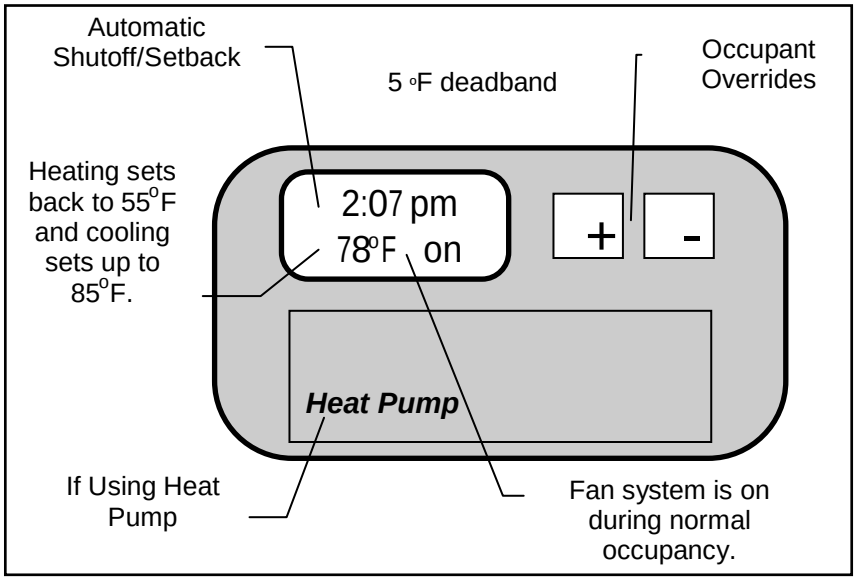
- Required for outdoor-air and exhaust systems with design air flow rates > 3000 CFM
- Must automatically close during periods of non-use
- Exception
  - Where restricted by health and life safety codes

Natural Ventilation

- Use windows, doors, louvers or other openings to provide outdoor air
  - Refer to local code
  - Section 402 of the IMC

Heating and Cooling System Controls

- Each system must have a thermostat to control heating and/or cooling to each zone



Heating and Cooling Loads

- Design heating and cooling loads
  - determine using procedures equivalent to Chapters 27 and 28 of the ASHRAE Handbook of Fundamentals or an approved equivalent computation procedure
- All equipment and systems sized to meet calculated loads
  - Exceptions:
    - Capacity may be greater than loads for standby purposes
    - Multiple units of same equipment type whose combined capacities exceed loads

Economizers

- Use of outside air to actively cool interior spaces
- Adjusts outside air and exhaust dampers to utilize 100 percent outside air when its temperature makes it advantageous to do so
- Most appropriate for thermally massive buildings which have high internal loads and require cooling in interior zones year round

Economizers *(cont'd)*

- Integrated air economizers required on systems
  - Cooling capacity $\geq$ 90,000 Btu/h
- Not required in climate zones 1a, 1b, 2a, 2b, 3b
  - Check your location
- Not required for hotel/motel guest rooms, residential spaces, or supermarkets

Economizers *(cont'd)*

- Trade-off high cooling efficiency for economizer
  - Total cooling capacity
  - Climate zones
  - Equipment efficiency (EER)

Total Cooling Capacity of Equipment	Building Location		
	Zones 6a, 9a, 10a, 11a, 12a, 12b, 13a, 13b, 14a, 14b, 15-19	**Zones 3a, 4a, 7a, 8, 9b, 10b, 11b**	**Zones 4b, 5a, 5b, 6b, 7b**
90,000 Btu/h to 134,999 Btu/h	N/A	11.4 EER	10.4 EER
135,000 Btu/h to 759,999 Btu/h	N/A	10.9 EER	9.9 EER
760,000 Btu/h or more	N/A	10.5 EER	9.6 EER

Economizers *(cont'd)*

- Controls
  - Two-stage thermostat and an economizer controller
    - Dry-bulb temperature, or enthalpy, or combination
  - Typically integrated in field and factory installed economizers

Duct Construction

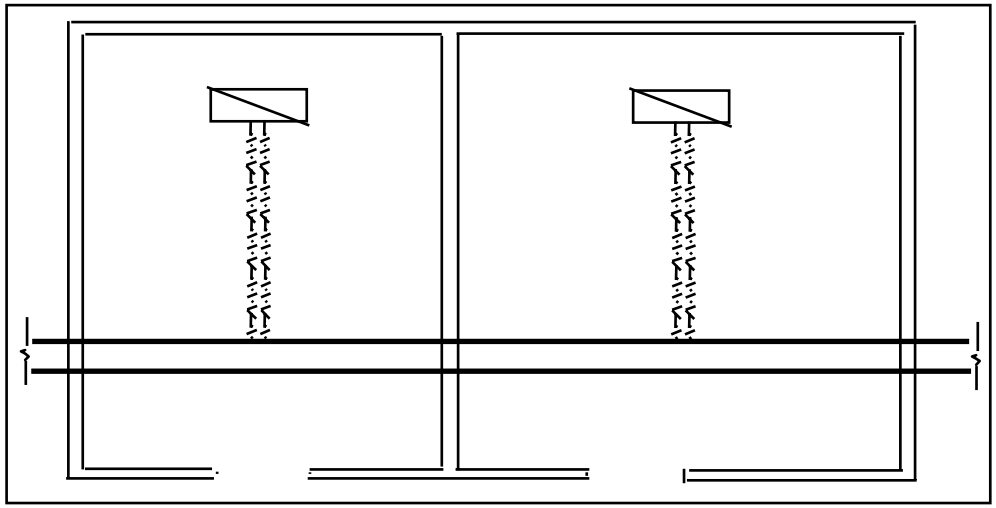
- Two key areas of energy loss in duct work
  - Insulation
  - Sealing

Duct Insulation

- Required for supply and return ducts
- Requirements determined by
  - Duct location
    - Ducts in unconditioned spaces = R-5
    - Ducts outside the building = R-8

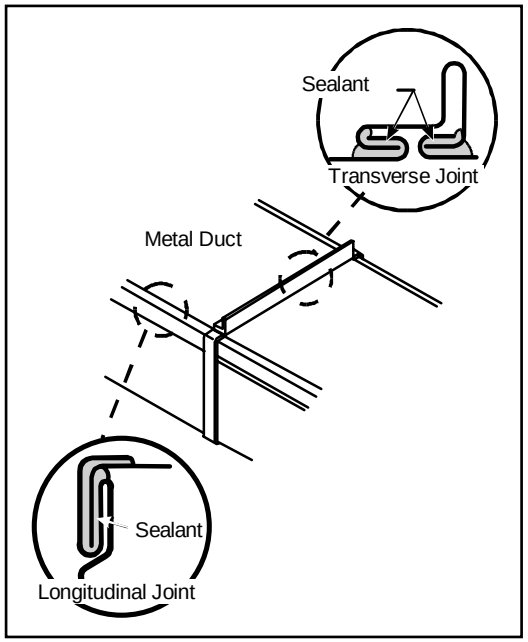
Duct Sealing

- Flexible ducts
  - Metal bands should be used on all duct connections
  - Duct mastic is strongly recommended on all joints
  - Seal all connections, grills, air handlers, penetrations, etc.



Duct Sealing *(cont'd)*

- Metal ducts > 0.5 inch water column
  - Seal transverse seams
  - Use exterior duct sealant



Documentation

- HVAC system compliance should be documented on plans
  - Equipment schedule
  - Mechanical duct layout
  - Plan notes
  - Specifications

Hydronic Heating

- Heating only through individually controlled radiators or fan-coils and served by central hot water boiler
- Hydronic heating and cooling coils - test connections
- Components are required on zonal heating systems
  - thermostats
  - new equipment boilers and circulation pumps
  - pipe insulation
    - 1/2 in. on all branches for individual terminal units
    - 1 1/2 in. on all circulation loop piping
  - variable flow controls or temperature reset controls

Hydronic Heating

- Requirements for part-load controls on systems > 600,000 Btu/hr
  - water temperature reset
    - controls must decrease water temperature at least 25% of (design supply - return water)

OR

  - variable flow
    - variable-frequency drive on pump
    - multiple, staged pumps
    - control valves

Zones

- Zone terminal controls must:
  - reduce the supply of primary supply air prior to reheating, recooling or mixing air streams (if system is variable-flow and serves multiple zones)
  - be installed to reduce the flow of air through one duct to a minimum prior to mixing with air from another duct
  - be controlled to prevent simultaneous supply of warm air and cool air to zones (in three-duct systems)

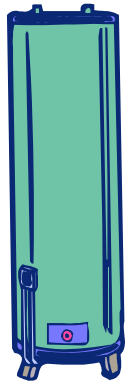
Multiple Zone Systems

- Each zone must have its own temperature control device
- Must include controls to reset supply air temperature by at least 25% of the difference between the design supply air temperature and the design room temperature

Variable Air Volume Controls

- Not required in zones:
  - with special pressurization or cross-contamination requirements
  - where at least 75% of the reheating and recooling energy is achieved through use of site-recovered or site solar energy
  - with special humidity control requirements for specialized processes
  - that require less than 300 cfm of supply air (provided total air flow to these zones does not exceed 10% of the total)
- Not required if constant volume is necessary to meet outside-air requirements of Chapter 4 of the IMC

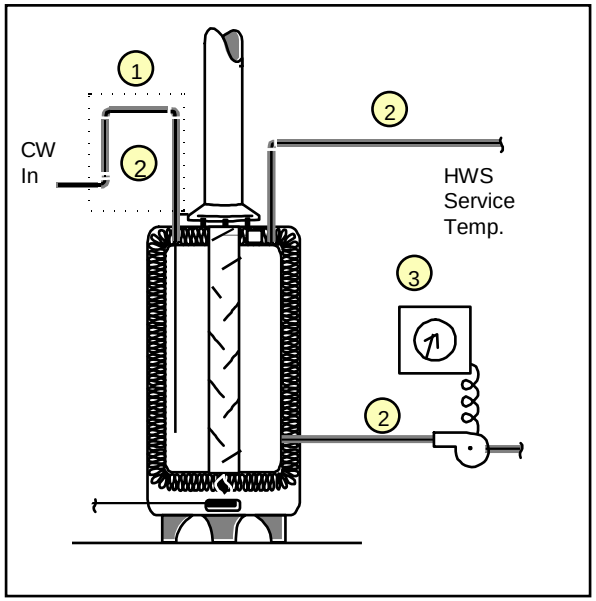
Water Heating



- NAECA regulated water heating equipment allowed under COM*check-EZ* ™
  - Electric heaters
  - Fuel-fired storage
  - Packaged boilers
  - Instantaneous
  - Pool and spa heaters
- No gas or oil water heaters > 140 gallons

Water Heating *(cont'd)*

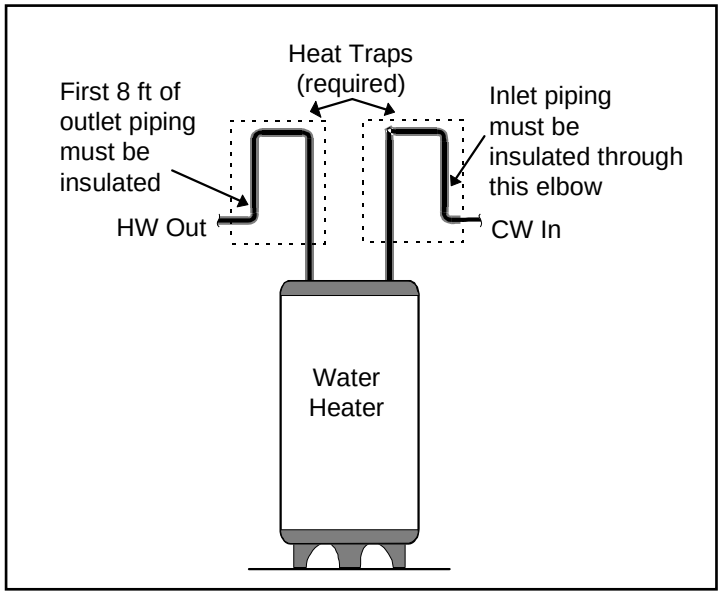
- Summary of requirements



1. Heat traps to reduce standby losses
2. Pipe insulation to reduce distribution and standby losses
3. Circulation loop temperature controls to reduce distribution losses

Heat Traps

- Required on noncirculating hot water systems



Pipe Insulation

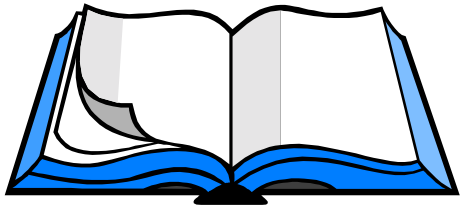
- Circulating systems
  - 1 in. of insulation required on all circulation piping
- Noncirculating system insulation requirements
  - First eight feet of outlet piping
  - Inlet piping between the storage tank and a heat trap
  - Use circulating system pipe insulation table

Circulation Loop Controls

- Application: circulating hot water systems
  - Automatic time switches required to turn off the pump and heat tracer tape when it is not in use

SCOPE AND APPLICATION
ENVELOPE COMPLIANCE
MECHANICAL COMPLIANCE
Lighting Compliance
SOFTWARE

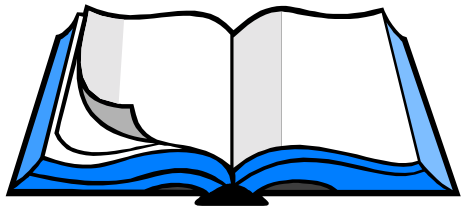
Scope



- Applies to the design of the:
  - first installed lighting systems
  - altered system that increases the lighting load
- Lighting systems used for specialized commercial, display and emergency use purposes are exempt

Scope

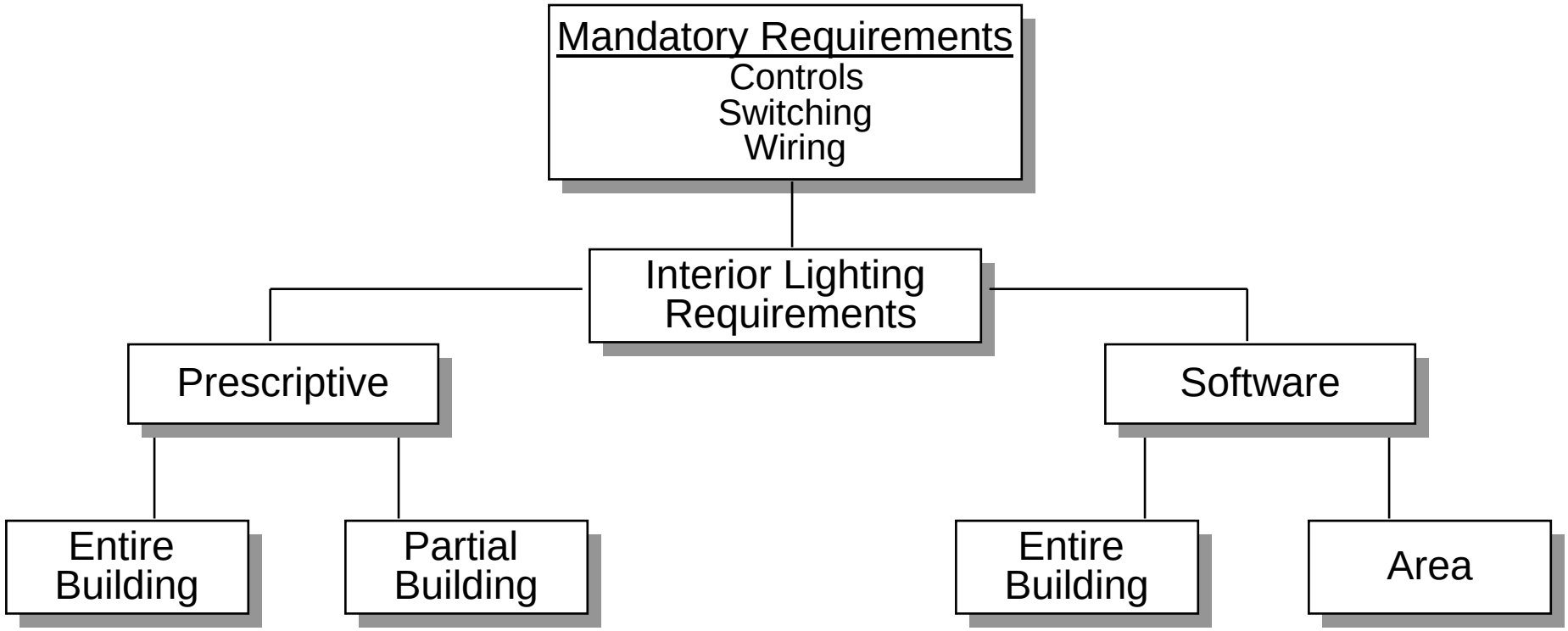
Exempt Systems



- specialized medical, dental, and research
- professional sports arenas
- display lighting for exhibits in galleries and museums
- guest room lighting in hotels and motels
- emergency lighting normally off

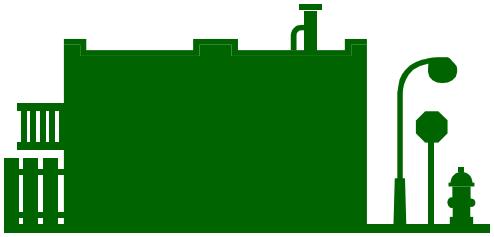
Scope

Interior Lighting Requirements



Scope

Exterior Lighting Requirements

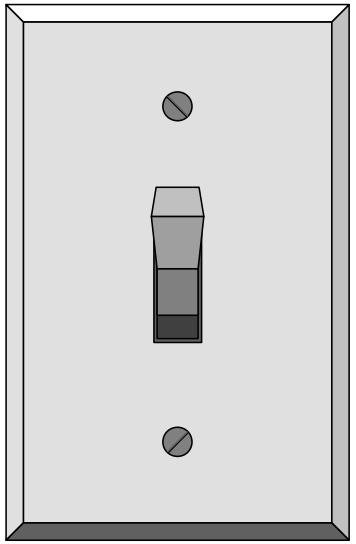


Mandatory Requirements
Controls

Exterior Lighting Requirements
Energy Efficient Sources
Use Limitations

Independent Switching

- Lighting controls required for each area enclosed by ceiling height partitions
- Switch locations
  - In view of lights
  - “On” or “off” indication from remote location
  - Occupancy sensor

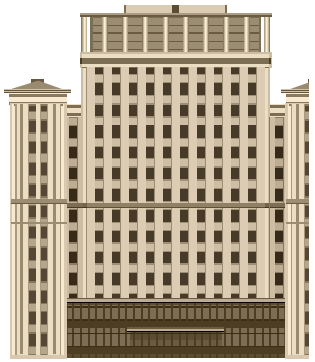


Independent Switching *(cont'd)*

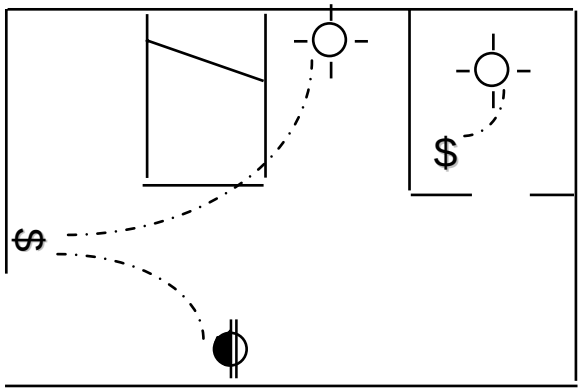
- Exceptions
  - Emergency/security lighting

  - Public areas
    - Building lobbies
    - Retail stores
    - Other public areas

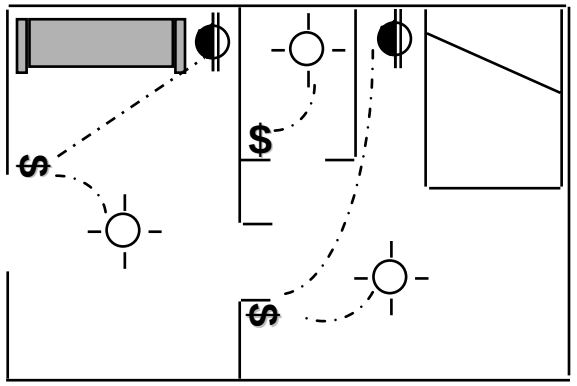
Hotel/Motel Guest Room Switching



- Master switch required at entry



Standard Room



Suite

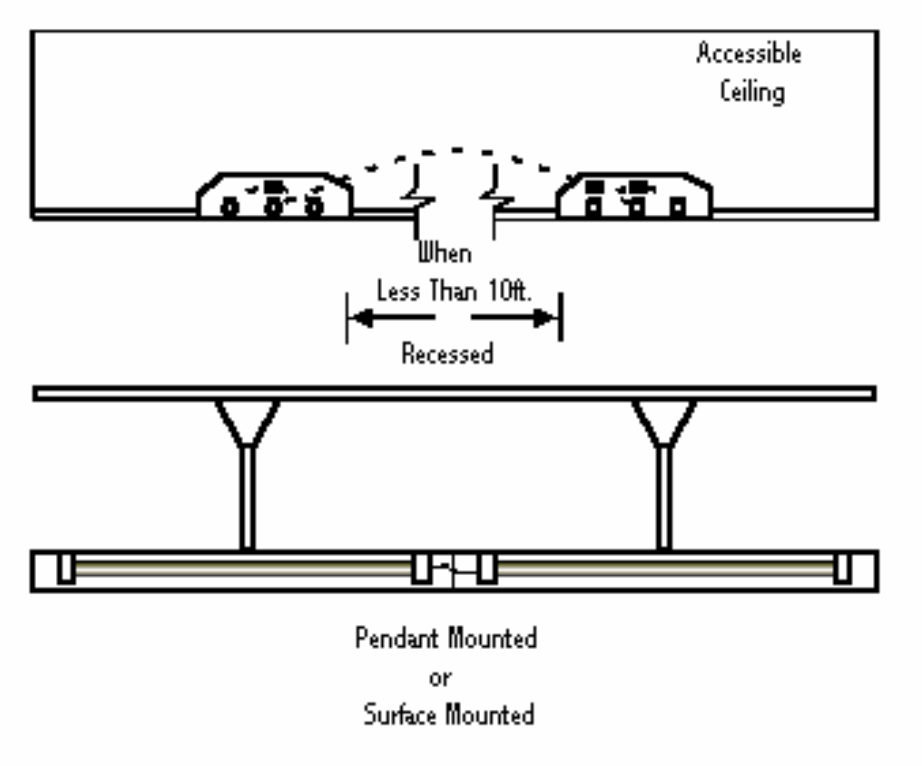
Bi-Level Switching

- Reduce connected lighting load by 50% for each space
- Exceptions
  - Area has one luminaire
  - Occupancy sensor controls area
  - Area is corridor, storage area, restroom, or main lobby

Exterior Lighting Controls

- Must be capable of automatically turning lights off when daylight is available
- Eligible controls
  - Directional photocell
  - Astronomical time switch
  - Building automation system with astronomical time switch capabilities
- Exceptions
  - Covered areas requiring illumination during daylight hours

Tandem Wiring

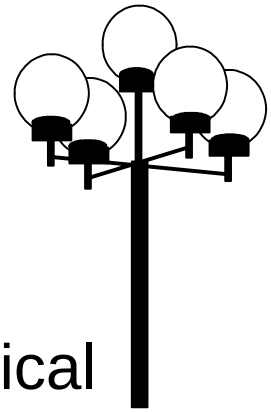


- Exceptions
  - Luminaires with electronic high-frequency ballasts
  - Luminaires not on same switch controls or not in the same area

Demonstrating Compliance

- Include the following information on the electrical plans
  - Switching schemes
  - Make/model of exterior lighting controls
  - Notes for tandem wiring

Exterior Lighting

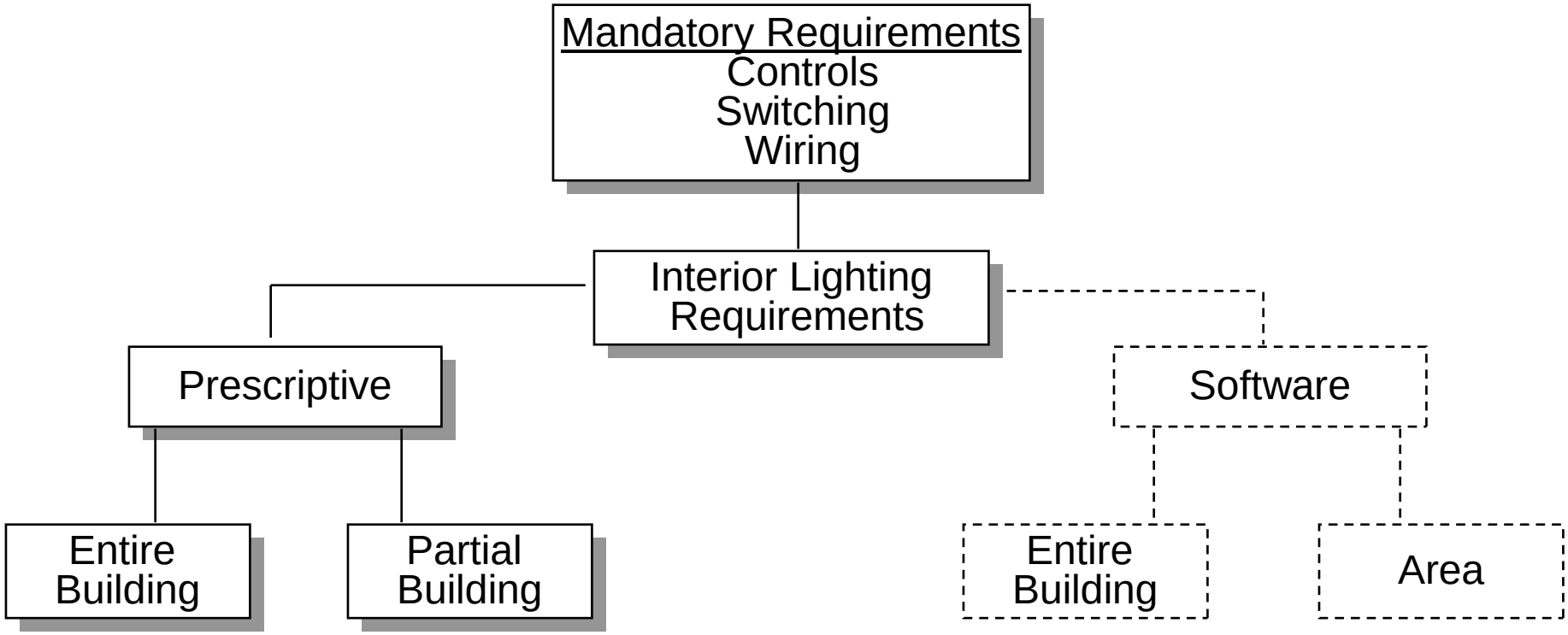


- Criteria
  - Lighting power supplied through building electrical service
  - Must use energy-efficient lighting sources to highlight paths, walkways and parking areas
    - > 45 Lumens/Watt
    - Fluorescent
    - Compact Fluorescent
    - Metal Halide
    - High Pressure Sodium

Exterior Lighting *(cont'd)*

- Exceptions
  - Signal, directional, and marker lighting associated with transportation systems
  - Lighting for historical landmarks or buildings
  - Integral lighting for advertising signage
  - Health, life safety and security lighting
  - Low-voltage lighting used exclusively for landscaping

Interior Lighting Requirements



Prescriptive - Entire Building

- Applies to whole building
- Refer to *Columns A* and *B* of Application Worksheet to determine if building is eligible

Section 1 - Allowed Lighting Power Calculation				
A	B	C	D	E
Building or Area Type	Entire Building (watts per sq ft)	Tenant Area or Portion of Building (watts per sq ft)	Building or Space (sq ft)	Allowed Watts** (B or C x D)
Office	1.3	1.5	10,000	13,000
			Total Allowed Watts	13,000
**May use only Column B or Column C to qualify project. Do not use more than one column.				

Prescriptive - Partial Building

- Project only applies to portion of entire building
- Project has more than one occupancy type
- Refer to *Columns A* and *C* of Application Worksheet

Section 1 - Allowed Lighting Power Calculation				
A	B	C	D	E
Building or Area Type	Entire Building (watts per sq ft)	Tenant Area or Portion of Building (watts per sq ft)	Building or Space (sq ft)	Allowed Watts** (B or C x D)
Corridor, Restroom, Support Area	N/A	0.8	1,000	800
Office	1.3	1.5	9,000	13,500
			Total Allowed Watts	14,500
**May use only Column B or Column C to qualify project. Do not use more than one column.				

Additional Power Allowances

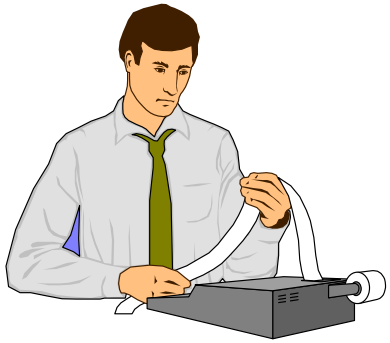
- Applied to either entire or partial building approaches
- Decorative lighting - 1 W/ft^2 for space
- VDT lighting - 0.35 W/ft^2 for space
- Fine merchandise display - 3.9 W/ft^2 for case or shelf
- Medical lighting - 1 W/ft^2 for space

Determining Total Project Watts

- Use Section 2 of Application Worksheet
  - Fixture ID
  - Fixture description
  - Lamp ballast
  - Quantity
  - Watts per fixture
  - Total wattage (D x E)

Example

Section 2 - Actual Lighting Power Calculation					
A	B	C	D	E	F
Fixture ID	Fixture Description	Lamp/Ballast	Quantity	Watts per Fixture	D x E
F1	*2x4 Recessed Troffer*	*T8/Electronic*	*110*	*121*	*13,310*
F2	*Recessed PL Fixture*	*PL 18*	*50*	*22*	*1,100*
F3	*Medium-Base Socket*	*100 W*	*30*	*75*	*2,250*
				Total Actual Watts	*16,660*



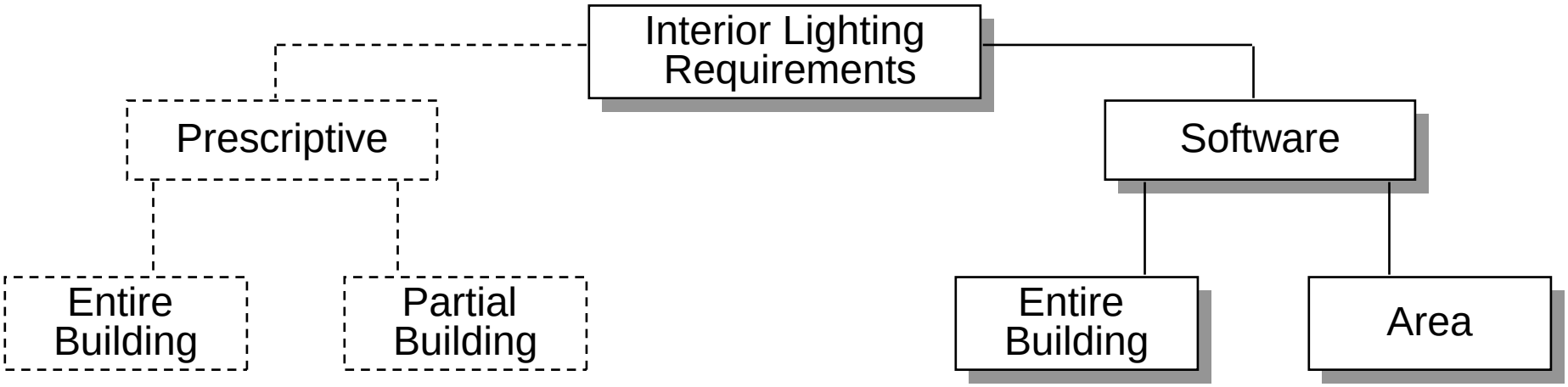
Does My Design Comply?

- Use Section 3 of Application Worksheet
  - Total allowed watts
  - Total project (actual) watts
- Compliance if Line 3 is $\geq$ 0

Example

Section 3 - Compliance Calculation		
1	Total Allowed Watts	*1700*
2	Total Actual Watts	*1666*
3	Project Compliance (line 1 - line 2; must be zero or greater)	*34*

Software


Interior Lighting Requirements
Prescriptive
Software
Entire Building
Partial Building
Entire Building
Area

SCOPE AND APPLICATION

ENVELOPE COMPLIANCE

MECHANICAL COMPLIANCE

LIGHTING COMPLIANCE

Software

Computer Requirements

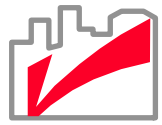
- Windows-based computer (PC)
  - 80486 processor
  - 6 MB extended RAM
  - VGA or Super VGA monitor
  - Microsoft-compatible mouse

Screen Layout

- Title bar - displays name of currently open project data file
- Menu bar - displays available menus - File, Edit, View, Options, Code, and Help
- Folder tabs – Project, Envelope, Lighting, and Mechanical folder tabs used to choose the respective screens
- Buttons - used to create a list of building and lighting components or to display additional input screens for describing mechanical systems in your building
- User prompts and status messages - displayed in bottom left corner of the screen
- Compliance results - color-coded results as a percentage by which performance is better than or worse than the minimum required by the code

Color Codes

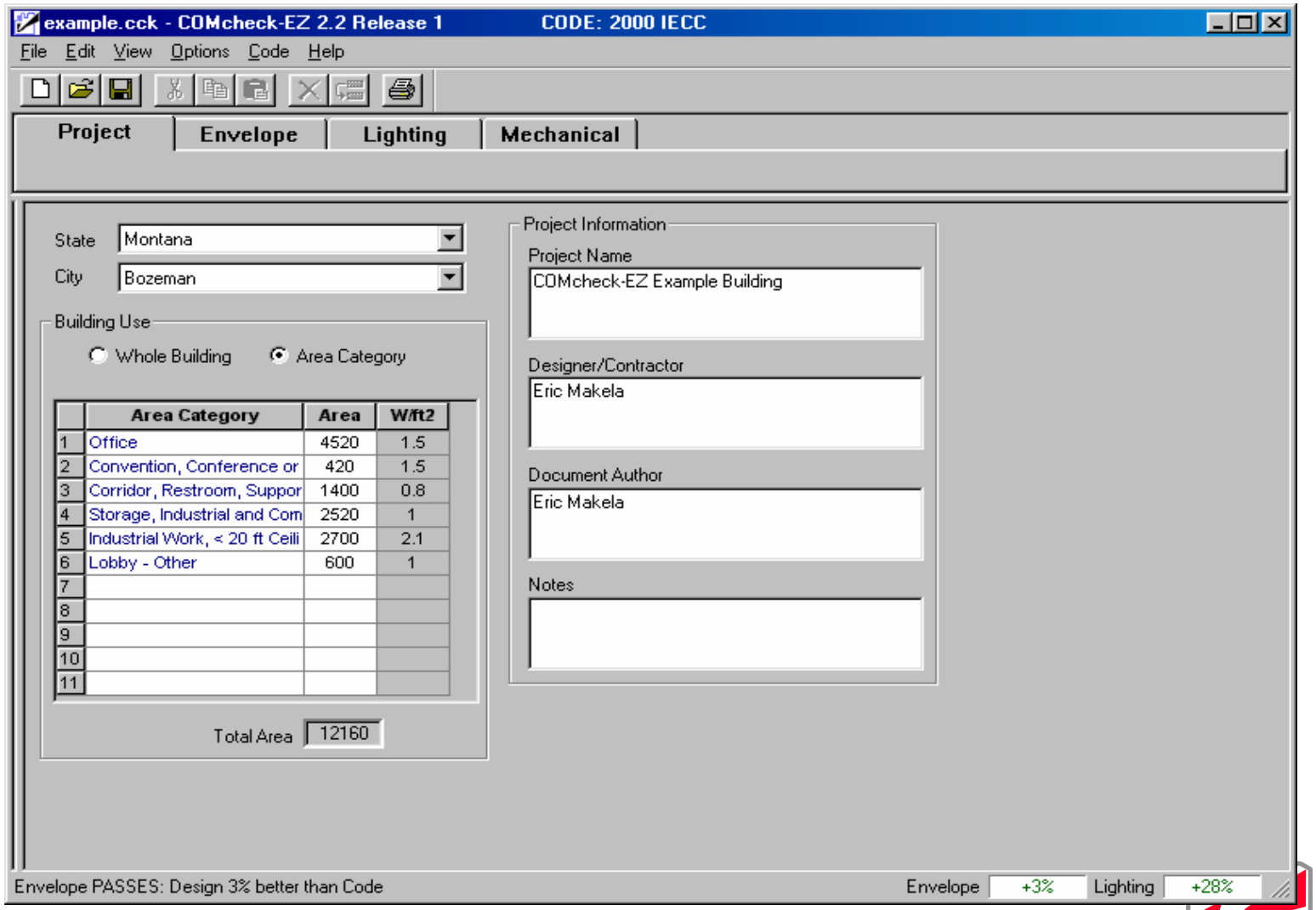
Color	Indication
Red on white	Data is either missing or not within a valid range
Dark blue on white	Data was selected from a drop-down list. Clicking on such fields with the left mouse button will redisplay the appropriate list
Black on white	Data is editable by user
Black on gray	Data was calculated by the program and is not directly editable by the user
Green on white	Design complies
Red on white	Design does not comply



Software Steps

- Project
  - Choose your building location and type
- Envelope
  - Choose your building location
  - Create a building description
- Lighting
  - Choose required lighting information
    - Whole Building
    - Area Category
  - Create a lighting description
- Mechanical

Project


example.cck - COMcheck-EZ 2.2 Release 1
CODE: 2000 IECC
File Edit View Options Code Help
Project
Envelope
Lighting
Mechanical
State
Montana
City
Bozeman
Building Use
Whole Building
Area Category
Area Category
Area
W/ft2
1 Office 4520 1.5
2 Convention, Conference or 420 1.5
3 Corridor, Restroom, Suppor 1400 0.8
4 Storage, Industrial and Com 2520 1
5 Industrial Work, < 20 ft Ceili 2700 2.1
6 Lobby - Other 600 1
Total Area
12160
Project Information
Project Name
COMcheck-EZ Example Building
Designer/Contractor
Eric Makela
Document Author
Eric Makela
Notes
Envelope PASSES: Design 3% better than Code
Envelope
+3%
Lighting
+28%

Create a Building Description

- Create a list of building components present in your proposed design
  - For each component selected, you must enter
    - component area (or perimeter for concrete slab on grade)
    - cavity R-value
    - continuous R-value and/or
    - assembly U-factor
- Check and edit default R-values and U-factors
- Program automatically updates the compliance results